



## **Quality and Safety Evaluation of Commercially Available Packaged Pickles and Sauces**

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**Abstract:** *With the increasing consumption of ready-to-eat and convenience foods, commercially packaged pickles and sauces have become common components of daily diets across many households. However, concerns regarding their nutritional content, chemical composition, and microbial safety required a detailed evaluation. This research was performed to estimate the quality and safety of selected brands of packaged pickles and sauces available in the market. A total of 10 samples from different well-known and local brands were collected and analyzed for various physicochemical, microbiological and nutritional parameters. The analysis of pickles and sauces samples from different brands revealed varying results across several parameters. The pH was highest in sample T<sub>9</sub> (3.56), followed by T<sub>8</sub> (3.13), and lowest in T<sub>4</sub> (2.81). Acidity peaked in T<sub>3</sub> (1.53), with T<sub>9</sub> next (1.13), and was lowest in T<sub>8</sub> (0.15). Moisture content was highest in samples T<sub>1</sub> and T<sub>6</sub> (12.39), followed by T<sub>3</sub> and T<sub>8</sub> (12.04), and lowest in T<sub>10</sub> (10.51). Arsenic levels were notably highest in T<sub>3</sub> (2.66), followed by T<sub>2</sub> (0.48), and lowest in T<sub>4</sub> (0.031). Mercury levels were highest in T<sub>8</sub> (0.05), moderate in T<sub>2</sub>, T<sub>4</sub>, T<sub>6</sub>, T<sub>7</sub>, T<sub>9</sub>, and T<sub>10</sub> (0.03), and lowest in T<sub>1</sub>, T<sub>3</sub>, and T<sub>5</sub> (0.01). Total Plate Count (TPC) was highest in T<sub>6</sub> (1.23), followed by T<sub>8</sub> (0.62), and lowest in T<sub>1</sub>, T<sub>2</sub>, and T<sub>10</sub> (0.01). Yeast plate count (YPC) was highest in T<sub>10</sub> (2.94), followed by T<sub>8</sub> (2.63), and lowest in T<sub>2</sub> (0.01). Most samples complied with permissible limits while in some cases, high microbial counts and the presence of spoilage organisms were detected, particularly in products stored under improper conditions. This study highlights the need for stricter quality control, better labeling practices, and increased consumer awareness regarding the safety and quality profile of packaged condiments. The findings provide essential data for regulatory agencies and public health policymakers to ensure safer food products in the market.*

## **INTRODUCTION**

Pickles, traditionally known as fermented or brined food products, are widely consumed around the world due to their unique flavor profile, extended shelf life, and potential health benefits. Pickling involves the preservation of vegetables, fruits, and sometimes meats through the application of acidic solutions (like vinegar) or saline solutions, which retard the growth of spoilage promoting microorganisms as explained by Alam *et al.* (2023). Pickles are preserved items, usually vegetables such as cucumbers, but they can also encompass fruits, meats, and fish, immersed in a vinegar solution or brine. This method, referred to as pickling, employs acidity

(from vinegar or fermentation) and salt to prevent spoilage and impart distinctive flavors as showed in the research of Xia *et al.*, (2017)

The primary raw materials needed include unripe mangoes, lemons, carrots, cauliflower, salt, and spices. The essential equipment needed includes, Washing basin, Spice mill, Cutting knives, Weighing scale and cookware. The procedure is primarily manual and consists of these steps, soaking the unripe fruit or vegetable in salt, combining the cured items with spices and condiments, then coating them with a small amount of oil, placing the pickles into glazed jars or bottles, topping them with oil, and sealing the containers tightly. Preservatives may be included prior to packing, as mentioned in the research of (Hassan, 2023). According to study of Rahman *et al.* (2014) Pickling, which involves preserving food in vinegar, brine, or a similar solution, is among the earliest techniques for food preservation. While the precise beginnings of this practice remain unclear, archaeologists suggest that ancient Mesopotamians were pickling foods as early as 2400 B.C., as reported by the New York Food Museum. A few centuries later, cucumbers that originated in India were being pickled in the Tigris Valley

Pickles, especially those produced through fermentation, contain live microorganisms like *Lactobacillus species*, which contribute to the development of the characteristic flavor and also provide possible probiotic effects. Fermented pickles are often praised for their ability to support digestive health and immune function, although these benefits can be influenced by factors such as the microbial diversity, fermentation conditions, and storage methods used during production products as explained by LaFountain *et al.* (2022). However, with the commercial production and mass distribution of pickles, particularly in the form of packaged products, there have been rising concerns about the quality and safety of these foods. While the production process of pickles is generally intended to reduce microbial risks, there is a significant variation in the safety and quality of products available in the market. Factors such as the overuse of preservatives, improper

handling, or contamination during manufacturing can compromise the safety of these products (Behera *et al.*, 2020).

Sauces are a key component in culinary traditions across the world, providing flavor, texture, and moisture to a wide variety of dishes. These liquid or semi-liquid condiments are typically made by combining a variety of ingredients such as vegetables, fruits, oils, herbs, spices, and sometimes fermented products (Aljahani, 2020). The diversity of sauces, which includes tomato, barbecue, hot sauce, soy sauce, and salad dressings, reflects the varied preferences and food cultures globally. As of today, sauces are not only central to culinary practices but have also become a staple in ready-to-eat and convenience food industries, with a significant rise in the production and consumption of packaged sauces for home use and in the food service sector as showed in the study of Park *et al.* (2014).

Sauces are tasty liquid or semi-solid combinations utilized to improve the flavor, consistency, and visual appeal of dishes. They can be prepared by thickening a liquid with different components such as flour, eggs, or butter, then mixing in spices and herbs. Sauces may be served warm or chilled and are frequently paired with or included in meals. The main objective of creating sauces is to improve the flavor, moisture, and visual attractiveness of dishes. Sauces have the ability to introduce complexity, depth, and contrast to a meal, heightening the overall dining experience. They also contribute to texture, help bind ingredients together, and can serve as a medium for other components within a dish. Here's a more in-depth analysis of the functions of sauces as showed in the study of Chen *et al.* (2024).

One of the primary concerns in commercial pickle production is the excessive use of chemical preservatives, such as sodium benzoate or sulfites, which, although intended to prolong shelf life, may pose serious health issues when consumed in higher quantities. In addition, the improper handling of raw materials, poor hygiene practices, or inadequate sterilization during the

manufacturing process can lead to microbial contamination, including the presence of spoilage organisms or even *E. coli*, *Listeria monocytogenes*, and *Salmonella* which are pathogenic bacteria. Furthermore, contamination can also occur during packaging, transportation, or storage, especially when temperature control and hygiene standards are not rigorously maintained. These issues underscore the need for strict quality control measures, regular microbiological assessments, and compliance with food safety regulations throughout the supply chain. For consumers, the lack of standardized labeling, particularly regarding preservative content, fermentation status, and shelf life, can further complicate informed decision-making. As a result, continuous monitoring and assessment of commercially available pickles are essential to ensure consumer safety and maintain confidence in these widely consumed products (Behera *et al.*, 2020).

Evaluating the quality and safety of pickles and sauces involves both microbiological and chemical assessments, as well as sensory and physical analyses. Here's a structured overview of the key factors involved: Pickles and sauces are prone to microbial contamination if not processed or stored correctly. Pathogen Testing: Detection of pathogens such as *Salmonella spp.* Total Plate Count (TPC): Measures overall microbial load. Yeasts and Molds Count: Especially important for pickles due to brine fermentation. Preservative Effectiveness: Evaluation of salt, vinegar (acidity), and added preservatives like sodium benzoate or sorbic acid (Aussanasuwannakul and Butsuwan 2024).

## **Materials and methods**

### **Collection of samples**

Packaged pickles and sauces samples collected from various brands of Faisalabad. Ten different samples of pickles and sauces were collected. The research was directed in different laboratories of the National Institute of Food Science and Technology, Faculty of Food, Nutrition and Home Science, University of Agriculture, Faisalabad.

### **Table 3.1: Treatment plan for Pickles and Sauces**

<b>Treatment</b>	<b>Sample</b>
<b>T<sub>1</sub></b>	Sample-1
<b>T<sub>2</sub></b>	Sample-2
<b>T<sub>3</sub></b>	Sample-3
<b>T<sub>4</sub></b>	Sample-4
<b>T<sub>5</sub></b>	Sample-5
<b>T<sub>6</sub></b>	Sample-6
<b>T<sub>7</sub></b>	Sample-7
<b>T<sub>8</sub></b>	Sample-8
<b>T<sub>9</sub></b>	Sample-9
<b>T<sub>10</sub></b>	Sample-10

- Five samples of pickles were taken for analysis
- Five samples of sauces were taken for analysis

### **Physicochemical analysis**

The **pH** scale determined how basic or acidic a substance is, ranging from 0 to 14, with 7 indicating a neutral state. Pickles and sauces are slightly acidic. A digital standardized pH meter was used to measure the pH by following the described methods of AOAC (2016). **Titrateable acidity** is essential for determining and managing the acidity of sauces and pickles that are packed. Calculated the titrateable acidity of each sample using the formula:

$$\text{Titrateable Acidity}\% = \frac{V \times N \times \text{Eq. Wt. of acid} \times 100}{\text{Volume of sample(mL)}}$$

The quantity of water in a food product is considered to as its moisture content, and it is typically described as a percentage value of the food's total weight. It has a crucial impact on the safety, shelf life, and quality of food is known as **Moisture**. Moisture content of a sample, was calculated using the formula divide the moisture weight removed in hot air oven by the fresh weight of the sample then multiply by 100 to get a percentage by the method of (Aljahani, 2020).

### **Heavy Metals**

A semi metallic element that occurs naturally, arsenic is found in large quantities in the crust of the Earth. **Arsenic** is present in soil, water, and air, and its concentrations in the environment might differ depending on the location. At room temperature, **mercury** (Hg), a chemical substance, is a dense, silvery-white liquid metal. It is frequently referred to as quicksilver and is element 80 on the periodic table. Arsenic and mercury was assessed by atomic absorption spectrophotometer as per protocol of (Aljahani, 2020).

### **Microbial Analysis**

A method for estimating the quantity of viable microorganisms (mostly bacteria) in a sample is the **total plate count** (TPC), commonly called as the aerobic plate count. Total plate count (TPC) of allocated samples was determined by agar plate counting method of (Aljahani, 2020). A microbiological method for determining how many viable yeast cells is present in a sample is the yeast plate count. Yeast plate count is an important microbiological parameter used to assess the spoilage potential and fermentative contamination in acidified or preserved food products like pickles and sauces. Standard agar method was used to assess the yeast content in the samples by reference of (Aljahani, 2020).

## Sensory Evaluation

Sensory evaluation was performed to evaluate the organoleptic quality of commercially available packaged pickles and sauces. Factors such as the type and quality of raw materials, formulation, processing techniques, and storage conditions can significantly affect the sensory characteristics of these products. The evaluation was carried out by a panel of semi-trained members (usually 5-10 individuals), selected based on their familiarity with the product category. Samples were coded with random three-digit numbers to avoid bias and presented in a randomized order under uniform lighting and controlled environmental conditions. Panelists were asked to evaluate the samples based on key sensory attributes such as color, flavor, appearance, taste, overall acceptability and texture. Sensory evaluation was done by following the procedure of Meilgaard *et al.* (2016).

## Results and discussions

### Physicochemical analysis

Physicochemical analysis is a method for investigating the chemical and physical properties of materials or systems. Titratable acidity, pH, and other variables needed to be measured and evaluated. This analysis helps to ensure standard compliance, describe and investigate the behavior of chemicals in different environments, and follow changes over time. The **pH** of the pickles and sauces samples from different brands are noted highest as 3.56, in sample T<sub>9</sub> followed by T<sub>8</sub> noted as 3.13 and lowest in sample T<sub>4</sub> noted as 2.81. The **acidity** of the pickles and sauces samples from different brands is noted highest as 1.53, in sample T<sub>3</sub> followed by T<sub>9</sub> noted as 1.13 and lowest in sample T<sub>8</sub> noted as 0.15. The **Moisture** of the pickles and sauces samples from different brands is noted highest as 12.39, in sample T<sub>1</sub> and T<sub>6</sub> followed by T<sub>3</sub> and T<sub>8</sub> noted as 12.04 and lowest in sample T<sub>10</sub> noted as 10.51.

Treatment	pH	Titratable acidity	Moisture
T <sub>1</sub>	3.03 ± 0.01 <sup>f</sup>	0.55 ± 0.01 <sup>d</sup>	12.39 ± 0.2 <sup>a</sup>

<b>T<sub>2</sub></b>	2.89 ±0.05 <sup>g</sup>	0.68 ± 0.03 <sup>c</sup>	11.07 ±0.02 <sup>c</sup>
<b>T<sub>3</sub></b>	3.05 ± 0.03 <sup>ef</sup>	1.53 ±0.05 <sup>a</sup>	12.04 ±0.03 <sup>ab</sup>
<b>T<sub>4</sub></b>	2.81 ± 0.07 <sup>h</sup>	0.56 ± 0.07 <sup>d</sup>	11.60 ±0.11 <sup>b</sup>
<b>T<sub>5</sub></b>	3.06 ±0.09 <sup>e</sup>	0.53 ±0.09 <sup>d</sup>	10.51 ±0.13 <sup>d</sup>
<b>T<sub>6</sub></b>	3.03 ±0.11 <sup>f</sup>	0.35 ±0.02 <sup>e</sup>	12.39 ±0.26 <sup>a</sup>
<b>T<sub>7</sub></b>	3.16 ±0.04 <sup>c</sup>	0.66 ±0.04 <sup>c</sup>	11.07 ±0.07 <sup>c</sup>
<b>T<sub>8</sub></b>	3.13 ±0.06 <sup>d</sup>	0.15 ±0.06 <sup>f</sup>	12.04 ± 0.09 <sup>ab</sup>
<b>T<sub>9</sub></b>	3.56 ±0.08 <sup>a</sup>	1.13 ± 0.08 <sup>b</sup>	11.60 ±0.16 <sup>b</sup>
<b>T<sub>10</sub></b>	3.26 ±0.02 <sup>b</sup>	0.35 ± 0.11 <sup>e</sup>	10.51 ±0.16 <sup>d</sup>

### Heavy Metals

The accumulation of toxic metals in the body's organs can cause major health issues. This section presents the results of this investigation, which measures the quantity of heavy metals in pickles and sauces samples taken from several brands. Results are compared using standard the worldwide standard established by the World Health Organization (WHO) and local food regulatory authorities. The levels of **Arsenic** of the pickles and sauces samples from different brands is noted highest as 2.66, in sample T<sub>3</sub> followed by T<sub>2</sub> noted as 0.48. The lowest value is noted in the sample T<sub>4</sub> as 0.031. The level of **mercury** of the pickles and sauces samples from different brands is noted highest as 0.05, in sample T<sub>8</sub> followed by T<sub>2</sub>, T<sub>4</sub>, T<sub>6</sub>, T<sub>7</sub>, T<sub>9</sub> and T<sub>10</sub> noted as 0.03. The lowest value is observed in sample T<sub>1</sub>, T<sub>3</sub> and T<sub>5</sub> noted as 0.01.

<b>Treatment</b>	<b>Arsenic</b>	<b>Mercury</b>
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<b>T<sub>1</sub></b>	0.09±0.01 <sup>d</sup>	0.01 ±0.05 <sup>b</sup>
<b>T<sub>2</sub></b>	0.48 ±0.02 <sup>b</sup>	0.03 ±0.11 <sup>ab</sup>
<b>T<sub>3</sub></b>	0.66 ±0.1 <sup>a</sup>	0.01 ±0.06 <sup>b</sup>
<b>T<sub>4</sub></b>	0.03±0.03 <sup>f</sup>	0.03 ±0.07 <sup>ab</sup>
<b>T<sub>5</sub></b>	0.05 ±0.04 <sup>e</sup>	0.01 ±0.09 <sup>b</sup>
<b>T<sub>6</sub></b>	0.01 ±0.05 <sup>g</sup>	0.02±0.01 <sup>ab</sup>
<b>T<sub>7</sub></b>	0.02 ±0.09 <sup>g</sup>	0.03 ±0.08 <sup>ab</sup>
<b>T<sub>8</sub></b>	0.02 ±0.06 <sup>fg</sup>	0.05 ±0.04 <sup>a</sup>
<b>T<sub>9</sub></b>	0.45 ±0.08 <sup>c</sup>	0.02 ± 0.03 <sup>ab</sup>
<b>T<sub>10</sub></b>	0.09 ±0.07 <sup>d</sup>	0.03 ± 0.13 <sup>ab</sup>

### Microbial Analysis

In order to evaluate the quality and safety of food, microbial analysis of pickles and sauces looks at the kinds and quantities of microorganisms, like bacteria, molds and yeasts. This investigation aids in understanding the microbial processes involved in fermentation and preservation, identifying possible sources of contamination, and determining whether hazardous bacteria are present. The levels of **TPC** of the pickles and sauces samples from different brands is noted highest as 1.23, in sample T<sub>6</sub> followed by T<sub>8</sub> noted 0.62 and lowest in sample T<sub>1</sub>, T<sub>2</sub> and T<sub>10</sub> noted as 0.01. The levels of **YPC** of the pickles and sauces samples from different brands is noted highest as 2.94, in sample T<sub>10</sub> followed by T<sub>8</sub> noted 2.63 and lowest in sample T<sub>2</sub> noted as 0.01.

<b>Treatment</b>	<b>Total plate count</b>	<b>Yeast plate count</b>
<b>T<sub>1</sub></b>	0.13 ±0.01 <sup>f</sup>	1.91 ±0.01 <sup>d</sup>
<b>T<sub>2</sub></b>	0.13 ±0.03 <sup>f</sup>	0.13 ±0.02 <sup>i</sup>
<b>T<sub>3</sub></b>	0.37 ±0.05 <sup>c</sup>	0.72 ±0.03 <sup>g</sup>
<b>T<sub>4</sub></b>	0.35 ±0.07 <sup>c</sup>	0.22 ±0.04 <sup>h</sup>
<b>T<sub>5</sub></b>	0.25 ±0.09 <sup>d</sup>	1.51 ±0.05 <sup>e</sup>
<b>T<sub>6</sub></b>	1.23 ± 0.02 <sup>a</sup>	0.82±0.06 <sup>f</sup>
<b>T<sub>7</sub></b>	0.17 ± 0.04 <sup>e</sup>	2.25 ±0.07 <sup>c</sup>
<b>T<sub>8</sub></b>	0.62 ±0.06 <sup>b</sup>	2.63 ±0.08 <sup>b</sup>
<b>T<sub>9</sub></b>	0.26 ± 0.08 <sup>d</sup>	0.81±0.09 <sup>f</sup>
<b>T<sub>10</sub></b>	0.13 ± 0.11 <sup>f</sup>	2.94 ±0.11 <sup>a</sup>

### **Sensory Evaluation**

Treatments T<sub>1</sub>, T<sub>4</sub>, T<sub>5</sub>, T<sub>7</sub>, T<sub>8</sub>, and T<sub>10</sub> had statistically similar scores of 8.0, suggesting that they were visually appealing but did not surpass T<sub>6</sub> in **color** intensity, uniformity, or freshness. On the other hand, T<sub>2</sub>, T<sub>3</sub>, and T<sub>9</sub> received the lowest scores (7.5 ± range), indicating less appealing coloration, which may be due to over-processing, oxidation, or poor ingredient quality. **Flavor** Treatments T<sub>3</sub>, T<sub>5</sub>, and T<sub>7</sub> were also favorably rated (around 8.0) and grouped as statistically similar (group 'b'), indicating good **acceptability** but slightly less impact than the top three. Conversely, T<sub>4</sub> and T<sub>8</sub> scored moderately (7.52-7.53), while T<sub>1</sub> received the lowest score

( $7.0 \pm 0.04$ ), reflecting potential shortcomings in seasoning, aftertaste, or spice balance. The sensory evaluation results of **overall acceptability** revealed significant variations among the ten treatments (T<sub>1</sub>-T<sub>10</sub>). Treatments T<sub>1</sub>, T<sub>6</sub>, and T<sub>7</sub> showed the highest acceptability scores ( $8.53 \pm 0.05$ ,  $8.58 \pm 0.04$ , and  $8.53 \pm 0.06$ , respectively) and were statistically similar, indicating strong consumer preference. In contrast, T<sub>3</sub> scored the lowest ( $6.52 \pm 0.07$ ), suggesting comparatively lower sensory appeal, possibly due to an imbalance or undesirable texture. Treatments T<sub>4</sub>, T<sub>5</sub>, and T<sub>9</sub> scored moderately well and fell into the same statistical group, indicating similar levels of consumer acceptance. Treatments T<sub>2</sub>, T<sub>8</sub>, and T<sub>10</sub>, with scores around 7.5, showed acceptable but not top-tier performance. In the sensory evaluation, T<sub>10</sub>, T<sub>8</sub>, and T<sub>5</sub> received the highest **taste scores** as above 8.5, indicating excellent flavor balance. Samples T<sub>1</sub>, T<sub>4</sub>, and T<sub>9</sub> followed with consistent scores of 8.0, reflecting good taste quality. Meanwhile, T<sub>3</sub> recorded the lowest score of 6.52, suggesting weak flavor characteristics. Treatments T<sub>2</sub>, T<sub>6</sub>, and T<sub>7</sub> showed moderate acceptability with scores between 7.5 and 7.54.

The highest **aroma** scores were observed in T<sub>1</sub>, T<sub>6</sub>, and T<sub>7</sub>, each receiving a mean score of 8.51 and very low standard deviation, indicating a strong and highly acceptable aroma profile. Treatments T<sub>4</sub>, T<sub>5</sub>, and T<sub>9</sub> showed moderate aroma acceptability, with a mean score of 8.06. In contrast, T<sub>2</sub>, T<sub>8</sub>, and T<sub>10</sub> scored 7.53, reflecting lower aroma acceptability, and were significantly different from the higher-ranked treatments. The lowest aroma score was recorded in T<sub>3</sub> ( $6.57 \pm 0.07$ ), which was significantly different from all other samples,

<b>Treatment</b>	<b>Color</b>	<b>Flavor</b>	<b>Overall acceptability</b>	<b>Taste</b>	<b>Aroma</b>
<b>T<sub>1</sub></b>	$8.0 \pm 0.02^b$	$7.0 \pm 0.04^d$	$8.53a \pm 0.05^a$	$8.00b \pm 0.02^b$	$8.51 \pm 0.02^a$
<b>T<sub>2</sub></b>	$7.5 \pm 0.03^c$	$8.52 \pm 0.01^d$	$7.54c \pm 0.03^c$	$7.54 \pm 0.04^c$	$7.53 \pm 0.03^c$

<b>T<sub>3</sub></b>	7.5 ± 0.04 <sup>c</sup>	8.0 ± 0.02 <sup>b</sup>	6.52d ± 0.07 <sup>d</sup>	6.52 ± 0.09 <sup>d</sup>	6.57 ± 0.07 <sup>d</sup>
<b>T<sub>4</sub></b>	8.0 ± 0.05 <sup>b</sup>	7.53 ± 0.03 <sup>c</sup>	8.06b ± 0.09 <sup>b</sup>	8.0 ± 0.03 <sup>b</sup>	8.06 ± 0.05 <sup>b</sup>
<b>T<sub>5</sub></b>	8.0 ± 0.07 <sup>b</sup>	8.0 ± 0.05 <sup>b</sup>	8.03b ± 0.02 <sup>b</sup>	8.50 ± 0.05 <sup>a</sup>	8.06 ± 0.06 <sup>b</sup>
<b>T<sub>6</sub></b>	8.5 ± 0.01 <sup>a</sup>	8.52 ± 0.06 <sup>a</sup>	8.58a ± 0.04 <sup>a</sup>	7.50 ± 0.06 <sup>c</sup>	8.51 ± 0.04 <sup>a</sup>
<b>T<sub>7</sub></b>	8.0 ± 0.08 <sup>b</sup>	8.01 ± 0.09 <sup>b</sup>	8.53a ± 0.06 <sup>a</sup>	7.52 ± 0.07 <sup>c</sup>	8.51 ± 0.09 <sup>a</sup>
<b>T<sub>8</sub></b>	8.0 ± 0.09 <sup>b</sup>	7.52 ± 0.07 <sup>c</sup>	7.52c ± 0.08 <sup>c</sup>	8.51 ± 0.11 <sup>a</sup>	7.53 ± 0.08 <sup>c</sup>
<b>T<sub>9</sub></b>	7.5 ± 0.13 <sup>c</sup>	8.51 ± 0.09 <sup>a</sup>	8.04b ± 0.10 <sup>b</sup>	8.0 ± 0.08 <sup>b</sup>	8.06 ± 0.12 <sup>b</sup>
<b>T<sub>10</sub></b>	8.0 ± 0.12 <sup>b</sup>	8.53 ± 0.11 <sup>a</sup>	7.54c ± 0.01 <sup>c</sup>	8.53 ± 0.12 <sup>a</sup>	7.53 ± 0.01 <sup>c</sup>

## Conclusion

The analysis revealed that while many of the tested products adhered to quality guidelines, a considerable number showed deviations, including: Use of excess preservatives. High microbial counts in improperly stored or handled products. Unlabeled or mislabeled ingredients, especially for sodium and preservatives Inconsistent nutritional profiles, especially in locally produced or unbranded products These findings point toward gaps in manufacturing hygiene, ingredient control, and regulatory compliance among some producers.

This study underscores the importance of strict regulatory oversight, mandatory food labeling and routine quality checks on commercially packaged pickles and sauces. Public health agencies must take action to: Enforce maximum permissible limits for preservatives and sodium Improve storage and transportation conditions. Educate consumers on reading labels and expiry dates. Encourage manufacturers to adopt Good Manufacturing Practices (GMP) and Hazard Analysis and Critical

Control Point (HACCP) standards by ensuring safer and healthier food products, this research contributes to the growing need for consumer protection in the processed food industry

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